

PANEL EXECUTIVE SUMMARY

Anthony Ephremides,
University of Maryland

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Historical Background

- NSF workshop recommendation - Summer 1998
- Panel formed-sponsors established -December 1998
- Kick-off meeting (panel & sponsors) - January 1999
- Workshop of North America industry representatives - March 15, 1999
- Visits to European sites - April 1999
- Visits to Japan Sites - May 1999
- Site visit reports prepared - Summer 1999
- Final workshop (Washington DC area) - Sept. 9, 1999
- Final report - by end of 1999

European Sites Visited

(April 1999)

- Alcatel
- CSELT
- Daimler Chrysler
- Ericsson
- Filtronic
- GMD Fokus
- GMD IPSI
- IBM Zurich
- IMST
- Nokia
- Philips

Japan Sites Visited

(May 1999)

- ATR
- Fujitsu
- KDD
- Matsushita CRL
- MRIT
- Mitsubishi
- Murata
- NEC (2 sites)
- NTT (2 sites)
- Tohoku University
- Toshiba
- YRP

Summary of Findings

Context of Study

- Explosive growth
- General consensus but high stakes (competitive environment)
- Drivers
 - Expanding personal communications
 - Ubiquitous internet services
 - Flexible indoor environments (home, office, factory)
 - Specialized applications (ITS, telemedicine, crisis management, law enforcement, etc.)
 - Military needs

Summary of Findings (cont.)

Bottlenecks/Challenges

- Channel (bandwidth-impairments)
- Integration/interoperability (fixed infrastructure, standards)
- Portability (cost, weight, energy)

Summary of Findings (cont.)

Long-range objectives (> 5 years)

- Higher bands (30-60-90 GHz)
 - Higher rates (hundreds of Mbps - Gbps)
 - Global standards
 - Spectrum management flexibility
 - Ultra-miniature systems (new materials, integration)
 - “Software Radio” (vertical integration)
- } At various levels of mobility

Vertical Integration (or “cutting through the layers”)

- OSI of ISO = useful framework but dated
- Layer boundaries fuzzy in wireless
- Examples
 - fuzziness of “link” notion
 - antenna design & DSP
 - routing & compression
 - error control & MAC & routing...

Summary of Findings (Cont.)

Near-Future Objectives (~ 5 years)

- Use of new components/materials & MMIC & MEMS Technologies
- Battery improvement/energy saving by DSP, antenna technology, network protocol
- Improved amplifier operation & design (both HPA & LNA)
- Better channel models/propagation
- Use of turbocodes, CDMA, SS for better error control & MAC

Summary of Findings (Cont.)

Near-Future Objectives (~ 5 years)

- Improved & “standard” network protocols (IP, ATM, access, routing) & architectures
- Incorporation of satellites (hybrid networks)
- Improved security (somewhat lacking)
- Variable network architectures (pico-cells, ad-hoc, skynet, etc.)

Summary of Findings (Cont.)

Immediate Objectives

- 3rd Generation (implementation, standardization, quality)
- Digital services
- Home networks (“bluetooth,” etc.)
- Market share!
- Killer - “APP”!

Overall Comparative Assessment

- Disclaimer
- Cellular penetration
- Cellular convergence in 3rd G
- Beyond 3rd G
- Ad-hoc networks
- Hardware
- Market pull vs. technology push

Some Technology Highpoints

- Notion of integrated design (software radio)
-- common theme
- Antenna integration in handset -- Nokia
- Polymer batteries/displays/electronics -- Philips
- Simplicity of first software radio versions -- Ericsson
- Channel characterizations (EM/statistical model integration) -- Philips

Some Technology Highpoints (Cont.'d)

- Packaging -- Matsushita
- 3-D Integration -- NTT
- Low-cost phased arrays -- NTT (& others)
- SKYNET -- YRP
- Actual MUD/SIC -- NTT DoCoMo
- Advanced miniature multimedia terminals
-- NTT DoCoMo

Major Focus Areas

- “System on a Chip” (hardware integration)
- Smart Antennas
- Vertical Integration (“software radio”)
- Impact on Education

Structure of Presentation (vertical rather than horizontal)

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|-----------------------------------|--------------------|
| 1. Hardware | T. Itoh, L. Katehi |
| 2. Channel Modeling & Propagation | M. Iskander |
| 3. Antennas & SP | J. Winters |
| 4. Coding/Modulation/Access | W. Stark |
| 5. Networking | R. Pickholtz |
| 6. Holistic Design (integration) | R. Rao |
| 7. Discussion | Panel/Audience |